STUDY ON RAINWATER HARVESTING AND DETERMINATION OF ITS QUALITY FOR DRINKING PURPOSE

By

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering.



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147/I, Green Road, Dhaka-1215, Bangladesh

Section: (24 A+E)

Semester -Year (i.e.: Spring-2025)

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BOARD OF EXAMINERS

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DECLARATION

This is to declare that, except where specific references are made to other investigators, the work embodied in this thesis paper is the result of an investigation carried out only by the author under type supervision of Associate Prof. Md. Lutfor Rahmann, Department of Civil Engineering. Sonargaon University (SU). Neither the thesis nor any part of it has been submitted to any other universities or other educational institution for a degree, diploma or other qualification

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Dedicated

to

"Our Parents"

ACKNOWLEDGEMENTS

Thanks to Allah for his unlimited kindness, blessing and giving us the ability and strength to this thesis

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ABSTRACT

The Study was conducted to Rainwater harvesting, an ancient practice, involves collecting and storing rainwater for various purposes, including domestic use, irrigation, Drinking, Gardening, Car washing and groundwater recharge. It's a sustainable water management strategy that reduces reliance on conventional water sources, like groundwater and surface water, especially in areas facing water scarcity. Rainwater harvesting systems typically include a catchment area (e.g., roof), a conveyance system (e.g., gutters and downpipes), a storage tank or cistern, and a distribution system. The harvested rainwater can be used directly for non-potable purposes like irrigation or, after treatment, for potable purposes like drinking and cooking. Proper design and implementation of rainwater harvesting systems are crucial for maximizing efficiency, minimizing contamination, and ensuring water quality.

Rainwater harvesting offers numerous benefits, including reduced water consumption, increased water availability during droughts, and a decrease in runoff and flooding. It can also contribute to groundwater recharge by infiltrating harvested rainwater into the soil, replenishing aquifers. Furthermore, rainwater harvesting can be cost-effective, especially for small-scale residential systems. However, challenges exist, such as the need for adequate storage capacity, the potential for contamination if not managed properly, and the need for regular maintenance of the system.

These abstract highlights the significance of rainwater harvesting as a sustainable water management strategy, outlining its components, benefits, and challenges. The practice can contribute to addressing water scarcity, reducing dependence on conventional water sources, and enhancing water security in urban and rural areas. Effective rainwater harvesting systems require careful planning, design, and implementation, considering local climate, water demand, and potential challenges. Research and development in rainwater treatment and management are continuously advancing, leading to more efficient and sustainable rainwater harvesting practices.

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CHAPTER 1

Introduction

1.1 Background and Motivations:

Bangladesh has an emerging problem with water supplies not adequate to meet even the minimum requirements for potable water. Surface water is being continuously contaminated by both industrial and human pollutions rapidly increasing demands due to population explosion results in withdrawal of ground water at a faster rate than it is replenished by recharge. There are several roofing materials that can used for rain water harvesting such as concrete surface, lime tracing, metal profile sheet & water proofing paint surface. Rainwater harvesting, the long traditional wisdom, might be a solution to the problem. Rainwater harvesting means proper use of rainwater by storing for domestic uses & recharging groundwater table.

1.2 Research Objectives and Overview

The research objective of the research is as below.

- To be aware about rainfall harvesting system.
- To analyze cost benefit of different type of roof top materials.

1.3 Organization of the thesis

Rainwater harvesting system using different materials is a good system or method for find out the which roof materials will be benefited for roof rainwater harvesting also aware to people about rain water harvesting.

The thesis is organized into five unique chapters that each address one of the following issues.

Chapter 1: Introduction and Objective. With the increase of population with the increase of water supply demand water layer is getting lower each year at a noticeable rate & surface water is being continuously contaminated by both industrial and human pollutions rapidly. Roof top rainwater harvesting system is long traditional wisdom to be solution water crisis & reduce the ground water. Our main objective is to be aware people about rainfall harvesting & cost benefit analysis of different type of roof top materials.

Chapter 2: Literature Review. Many countries in the world have implemented RWH system. We learn about their system. There have many types of roof top surface such as RCC, Metal, Patent stone & water proof paint. So we try to

analysis which roof top materials is benefited for roof top rain water harvesting system.

Chapter 3: Methodology. Throughout comprehension findings, we tried to evaluate a cost effective & benefited of roof top rainwater harvesting system usings different materials. For this we collected our individual four project rainwater harvesting related dada, fix the roof preparation cost, plumbing cost & total project implement cost so that we can find out the which roof top materials is benefited the rainwater harvesting among the four projects.

Chapter 4: Results and Discussion. In this chapter we collected individual four project data and analysis the four projects for find out the which roof top materials is benefited for roof top rainwater harvesting.

Chapter 5: Conclusions and Future Work. In this chapter, the outcomes of the study have been conclude obtained from our research and background study. We find out the metal roof top surface is benefited among the four proposed study project. Thereby more future studies should be done for more effectively implement RWH system for treated drinking water, 3D model & others.

CHAPTER 2
Literature Review

2.1 Introduction: Rainwater harvesting is a common practice in the countries and areas where the annual precipitation is high and pure drinking and usable water is scarce. All over the world, economical condition has prompted the low-income groups to harvest the rainwater for household and essential uses. We have worked different three area for roof top rain water harvesting at Dhaka district & analyze cost benefit successfully.

2.2 Historical Context and Evolution:

Rainwater harvesting is a common practice in the countries and areas where the annual precipitation is high and pure drinking and usable water is scarce. All over the world, economical condition has prompted the low-income groups to harvest the rainwater for household and essential uses. Several countries of the world in different regions have showed the popularity of this method. Originated almost 5000 years ago in Iraq, rainwater harvesting is practiced throughout the Middle East, the Indian subcontinent, Mexico, Africa, as well as in Australia and United States. Demand of water both from surface and underground sources continually increases with the increase in world population, leading to a consequence of crisis of water supply in different regions. Among other available alternative sources for water supply, rainwater harvesting has become the most economical solution for the water crisis. Studies and experiments have been done to establish the portability of rainwater 2, 3, 4. Composed in a comprehensive system, rainwater harvesting yields several benefits. Krishna5 indicates that the most important benefit of rainwater harvesting is that it is totally free; the only substantial cost involves storage. Increased awareness on water crisis has led rainwater harvesting to be proposed as a community facility. For example, small and medium residential and commercial constructions in the United States have shown increasing interest in rainwater harvesting since 19966. Cities and states around the world are adopting rules related rainwater harvesting, especially in United States4. Kenya has successfully adopted rainwater harvesting systems7. Kenya Rainwater Association uses low cost technical options to build the systems through community based organizations.

A combination of improved health awareness and benefits from clean and safe water and resulting income from sale of surplus farm produce gives rise to an increased willingness of people to pay for improved housing and water supply. A study by Mutekwa and Kusangaya8 indicates a successful adoption of RWH technologies in Zimbabwe that has contributed to alleviate problems faced by resource poor subsistence farmers. Benefits of RWH technologies include an increase in agricultural productivity, enhancing household food security and raising of incomes. The technologies also have assisted in improving environmental management through water conservation, reduction of soil erosion and resuscitation of wetlands in the study area. The study8 concludes that RWH technologies are suitable for smallholder farmers in semi-arid

areas provided they are properly tailored the conditions of the region where they are promoted. Other benefits of adopting RWH include improvement of people's standard of living and reduction in environmental degradation.

Practice in Bangladesh

Bangladesh used the surface water as the principal source for drinking water up to the recent past. But nowadays, withdrawal of groundwater has become norm. One of the major problems with groundwater is arsenic contamination. Almost 50 percent of the country suffers prom this contagion9. Figure 1 shows the alarming scale of the problem in Bangladesh. Rainwater is almost a free source of pure water and RWH inferred to collection and storage of rainwater aimed at harvesting surface and groundwater. It also includes the prevention of losses through and seepage all other hydrological and engineering intervention. In general water harvesting is the activity of direct collection of rainwater. The collected rainwater can be stored for direct use or can be recharged for developing the GWT. As rain is the first form of water in the hydrologic cycle, it's also become the primary source of water for us. Rivers, lakes and ground water are all secondary sources of water. Now we enormously depend on such secondary sources of water. The process is generally involved with the forgotten that rain is the ultimate source that recharged all secondary sources. Water harvesting means creating the optimum use of rainwater at the place where it falls so as to attain the self-sufficiency in water supply without being depends on to the remote water sources. Cities get lot of rain, but yet cities are facing water deficit. The only reason behind that is people are not reflected enough to the value of raindrop. At present the global average rainfall is estimated as 800 mm. However, this rainfall occurs in very short spells of time with a probably high intensity. These short time period and high intensity rain falling on the surface flow away rapidly, leaving a little amount to recharge groundwater table.

It has noticed at Cherrapunji, India that an average rainfall of 11000 mm per year still creating the shortage of drinking water. That is why it does not matter that how much rain falling in the place, if it's not captured. RWH may be a solution to solve this problem by capturing the run-off. Being a tropical country, Bangladesh receives heavy rainfall during the rainy season with an average annual rainfall of 2450mm. This amount makes rainwater harvesting an obvious solution for the country.

System Design and Technologies

Studies emphasize various RWH systems.

Rooftop Harvesting: Most common in urban areas. Includes gutters, filters, and storage tanks.

Surface Runoff Harvesting: Suitable for rural and agricultural settings.

Subsurface Systems: Incorporating underground tanks and recharge pits.
Technological innovations have led to improvements in water quality management, automation, and integration with urban infrastructure (Thomas & Durham, 2003).

Benefits and Effectiveness Environmental Benefits:
Reduces dependency on groundwater and municipal supply (Singh et al., 2018).
Mitigates urban flooding and erosion.
Enhances groundwater recharge (Boers & Ben-Asher, 1982).

Socio-economic Benefits:
Lowers water bills.
Provides a reliable water source during shortages.
Can be cost-effective over time (Pandey et al., 2003).

Challenges and Limitations
Despite the benefits, several challenges exist:

Water Quality Issues: Roof contaminants and storage tank maintenance can lead to microbial and chemical contamination (2011).

Public Awareness and Participation: Adoption is limited by a lack of awareness, especially in developing countries.

Policy and Regulation: Inconsistent or absent policies hinder widespread implementation (Campisano et al., 2017).

Economic Feasibility: High initial setup costs can deter investment without subsidies or incentives.

RWH in Urban vs Rural Contexts
Urban studies focus on integrating RWH with green infrastructure, while rural studies emphasize community-scale systems for agriculture and domestic use. Research suggests that RWH can contribute significantly to urban water demand reduction if adopted widely 2011.

Climate Change and RWH
RWH is increasingly viewed as a climate adaptation strategy. It buffers against rainfall variability and enhances resilience in arid and semi-arid regions. Simulation studies show RWH effectiveness under future climate scenarios, though site-specific analysis remains crucial (Mitchell et al., 2008).

Recent Advances and Research Trends
Smart RWH Systems: Integration of sensors and IoT for monitoring and automation.

GIS and Remote Sensing: Used for site suitability analysis and catchment planning.

Life Cycle Assessment (LCA): Studies assessing environmental impacts of RWH systems.

Policy and Institutional Frameworks

Successful implementation depends on enabling policies, subsidies, and public-private partnerships. Countries like Australia, India, and Brazil have made significant strides by mandating RWH in building codes and offering incentives (UNEP, 2009).

Future research: should focus on optimizing system design under varying climatic and socio-economic conditions, promoting participatory implementation, and enhancing regulatory support

This chapter should describe the relevant literature. It should present what has already been studied on the research topic. The relevant works should be organized in a structured manner. Relation between the previous works and the thesis work is particularly important to discuss in this chapter. The existing works should be analyzed thoroughly to point out their both strong and weak points. This review chapter is particularly important as it would identify the gaps in existing works and opportunities for further research in the related topics. Subsequently, the motivation of the thesis work will be clear to the reader. This chapter should have a brief introduction section (at least 4-5 sentences). Every chapter, except the Introduction and Conclusions chapters, may contain a brief introduction section.

CHAPTER 3
Methodology

1.1 Introduction

This chapter we will know about our proposed different project roof top rainwater harvesting system using different materials. also we show our individual project details, pluming cost, roof surface preparation cost & others cost details. We know many types of RWH system in Bangladesh.

1.2 Methodology Overview

Our Different proposed project roof top surface & proposed RWH system.
Rainwater harvesting Study Project No-1
Building Name: Residential #11 (Pipe Tube)
Location: Uttara Apartment Project at Uttara 3rd Phrase, Sector-18, Uttara, Dhaka
Roof Area: 134.96 m²

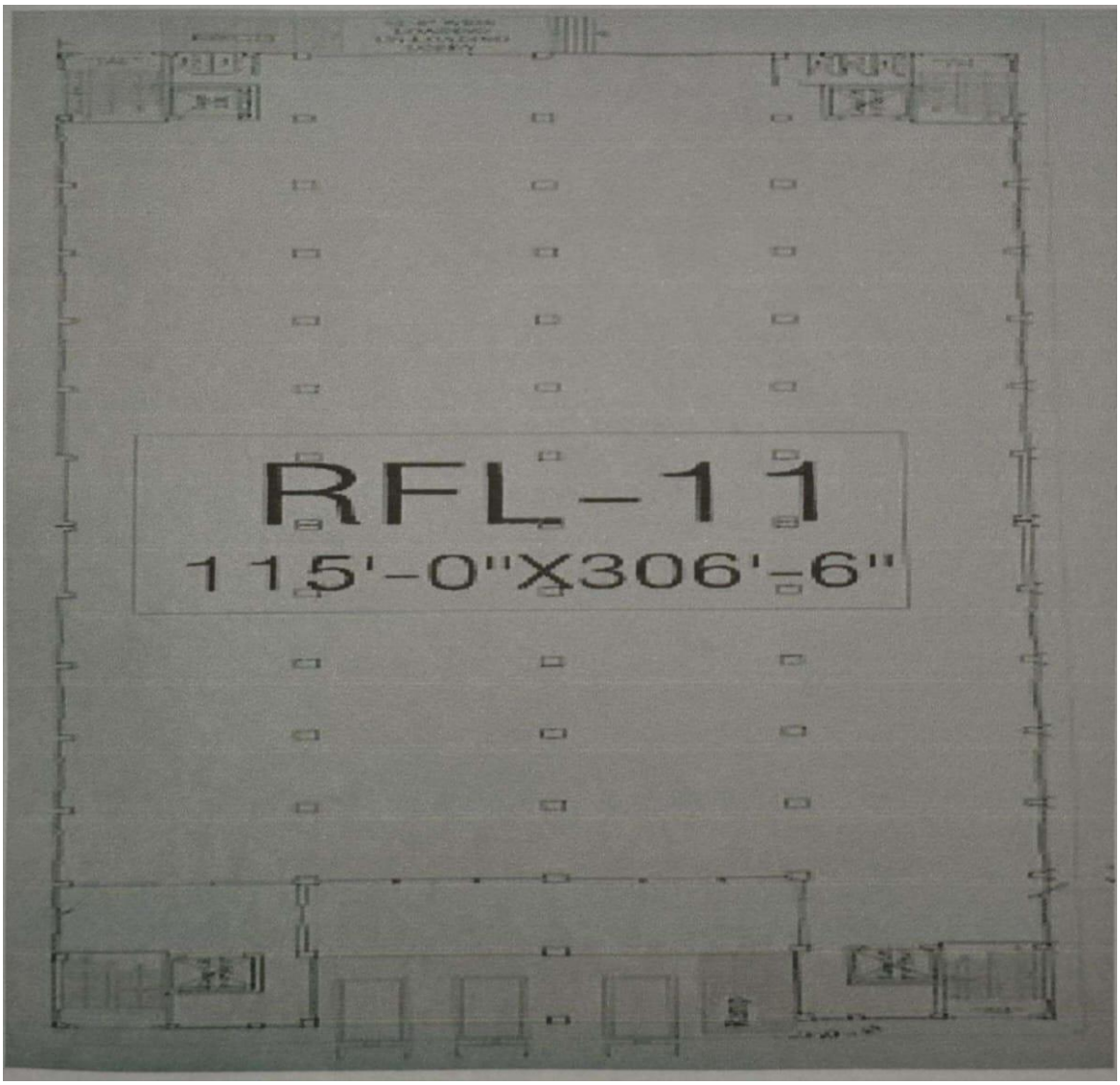


Figure 3.1: Roof Plan of study Building.



Figure 3.2: Down Site View of Study Building.



Figure 3.3: Roof top View of Study Building.

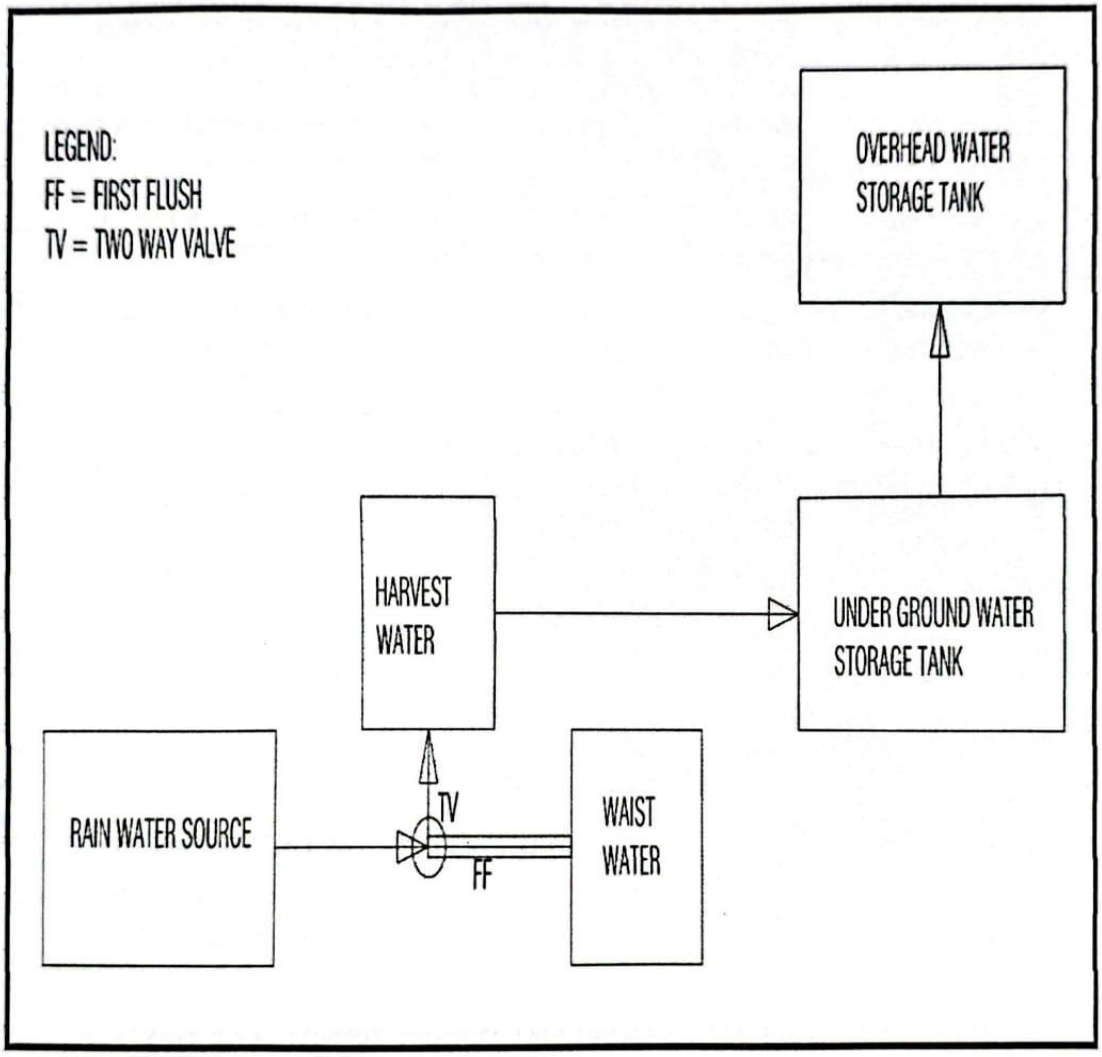


Figure 3.4: Process Diagram of Rainwater Harvesting Study Project.

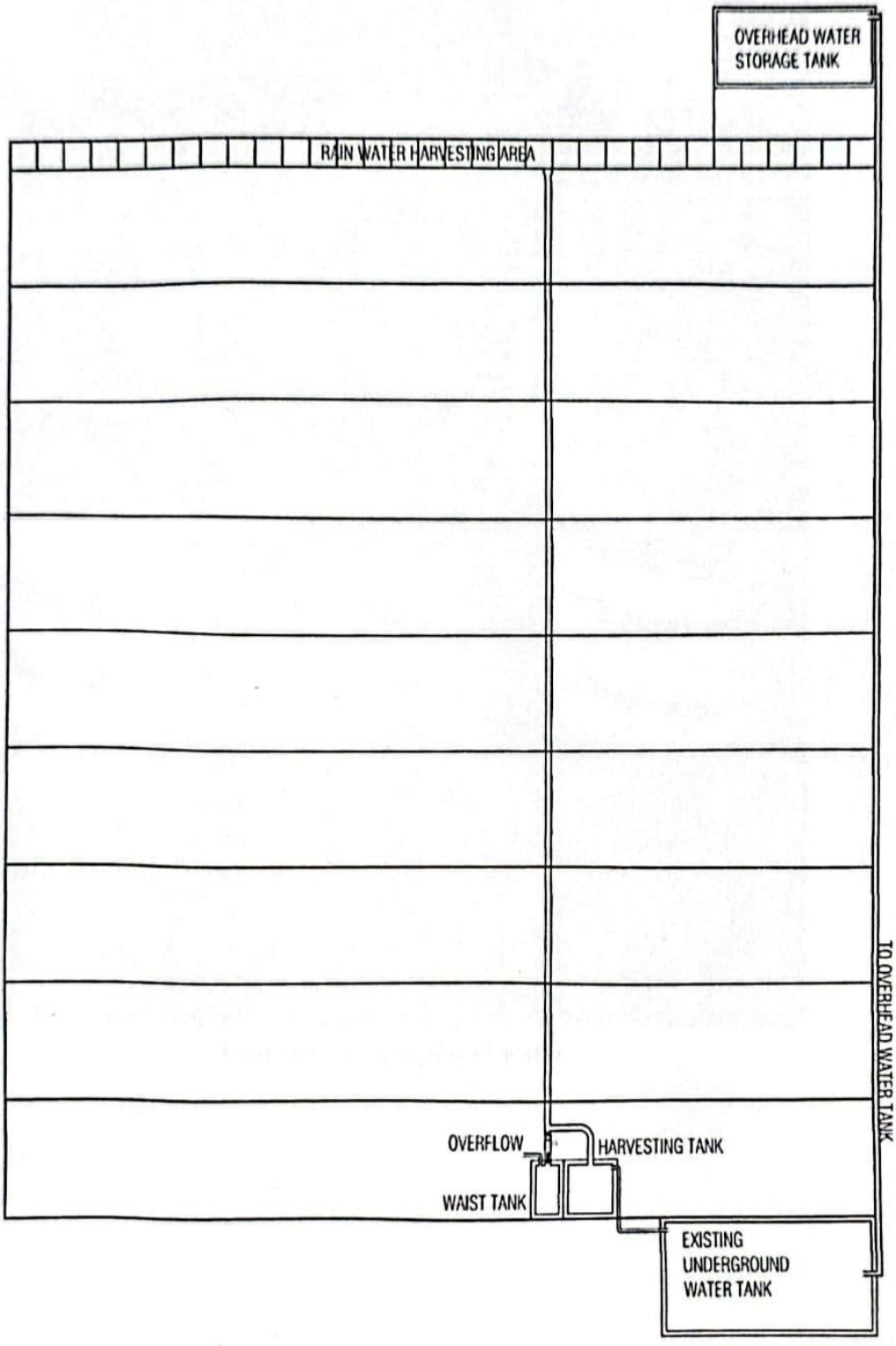


Figure 3.5: Sectional Elevation of Rainwater Harvesting Study Project.



Figure 3.6: Samples of Water

Rainwater harvesting Study Project No-2

Roof top surface & proposed Rainwater Harvesting system.

Building Name: RFL #02 (Bizli Cable)

Location: Aftabnagar, Dhaka

Roof Area: 143.23 m²

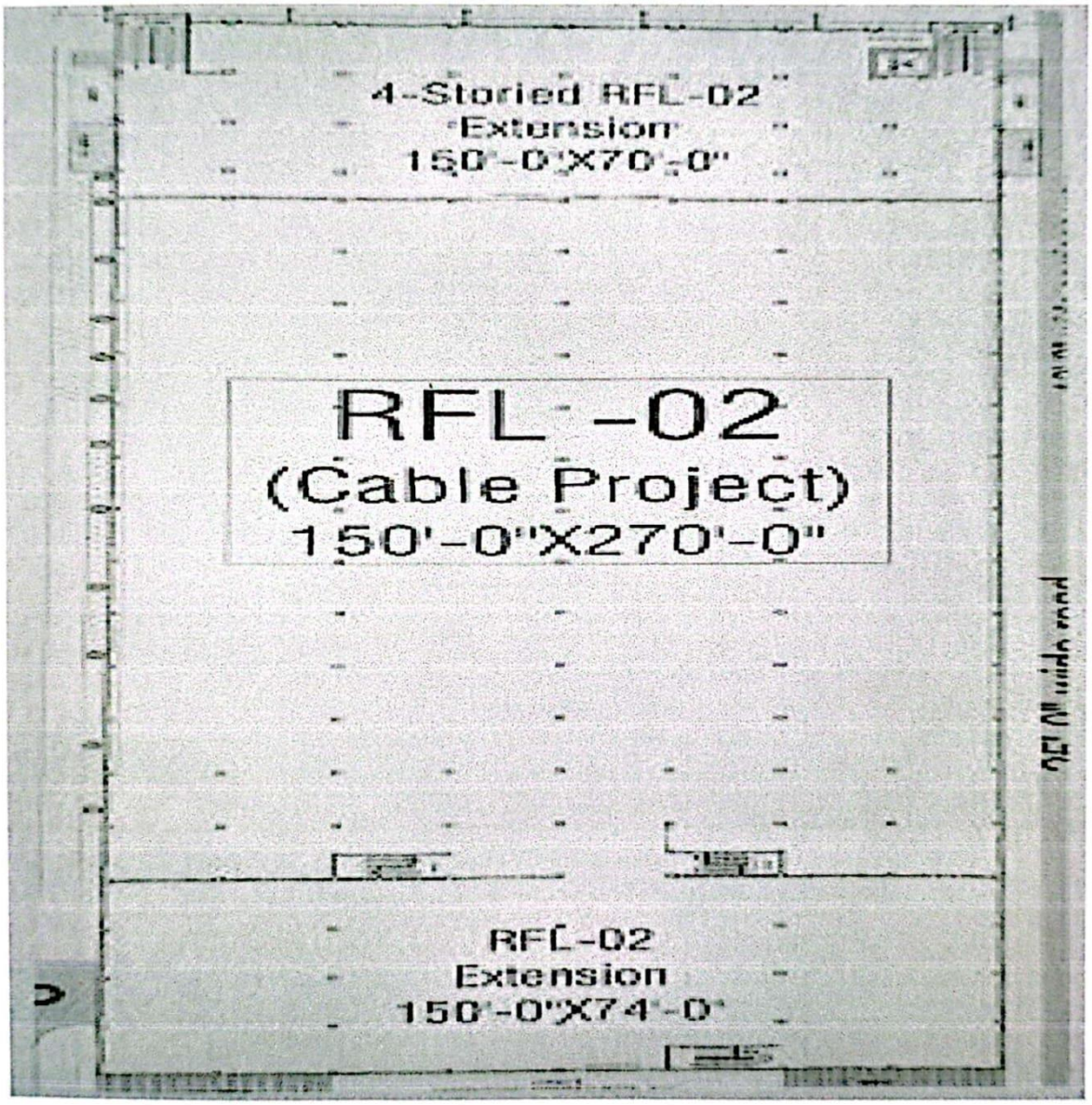


Figure 3.7: Roof Plan of study Building.

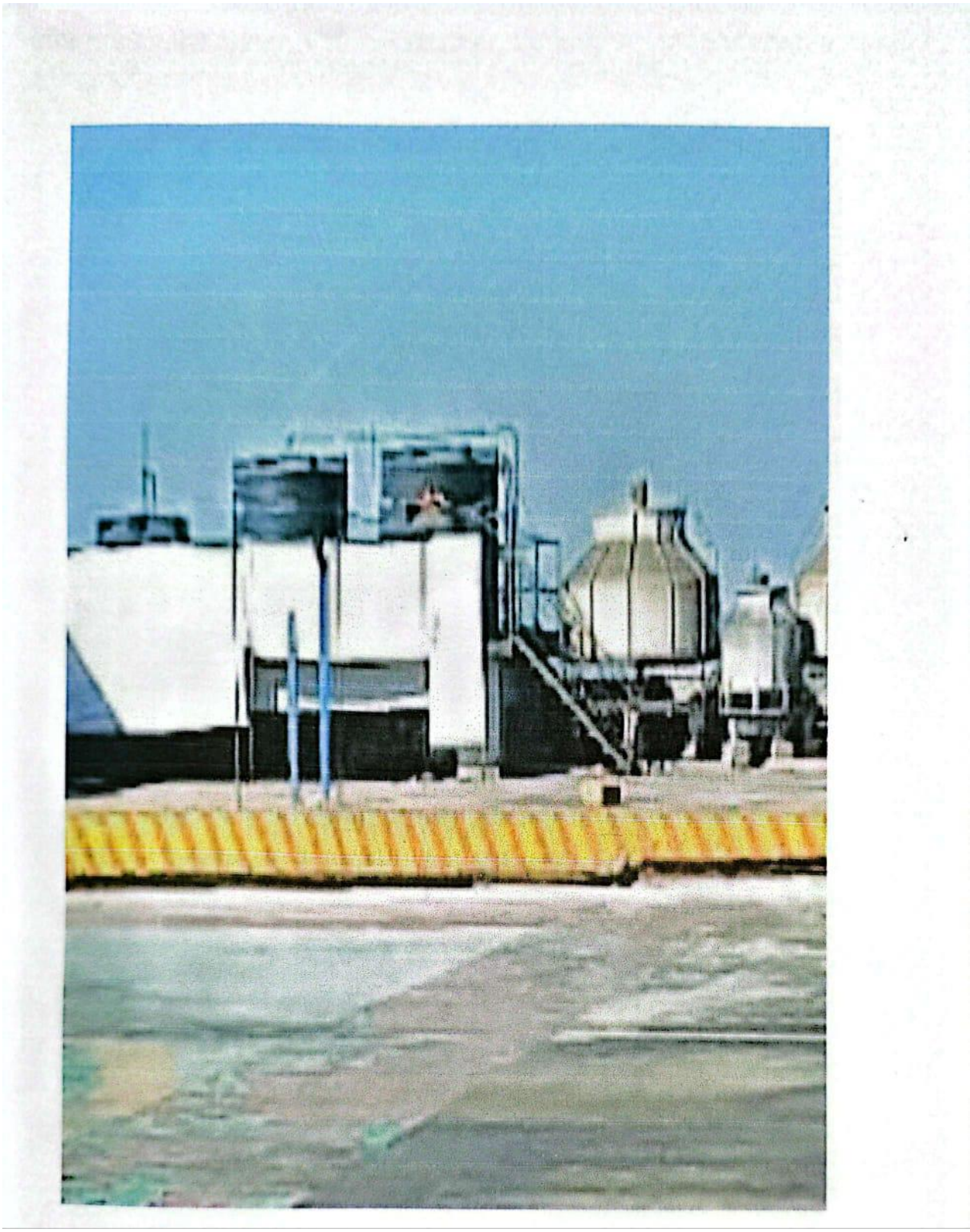


Figure 3.8: Roof top View of Study Building.

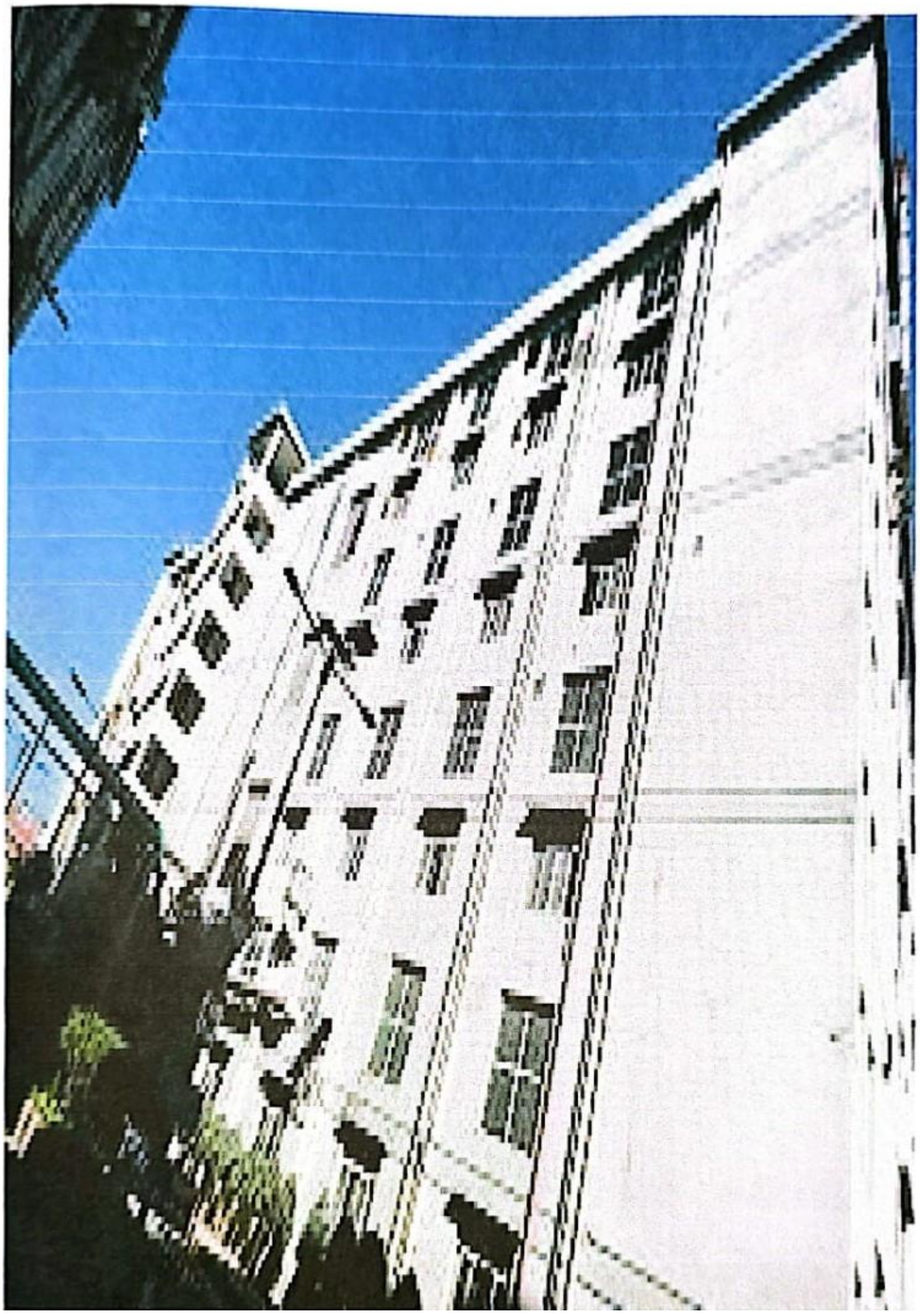


Figure 3.9: Site View of Study Building.

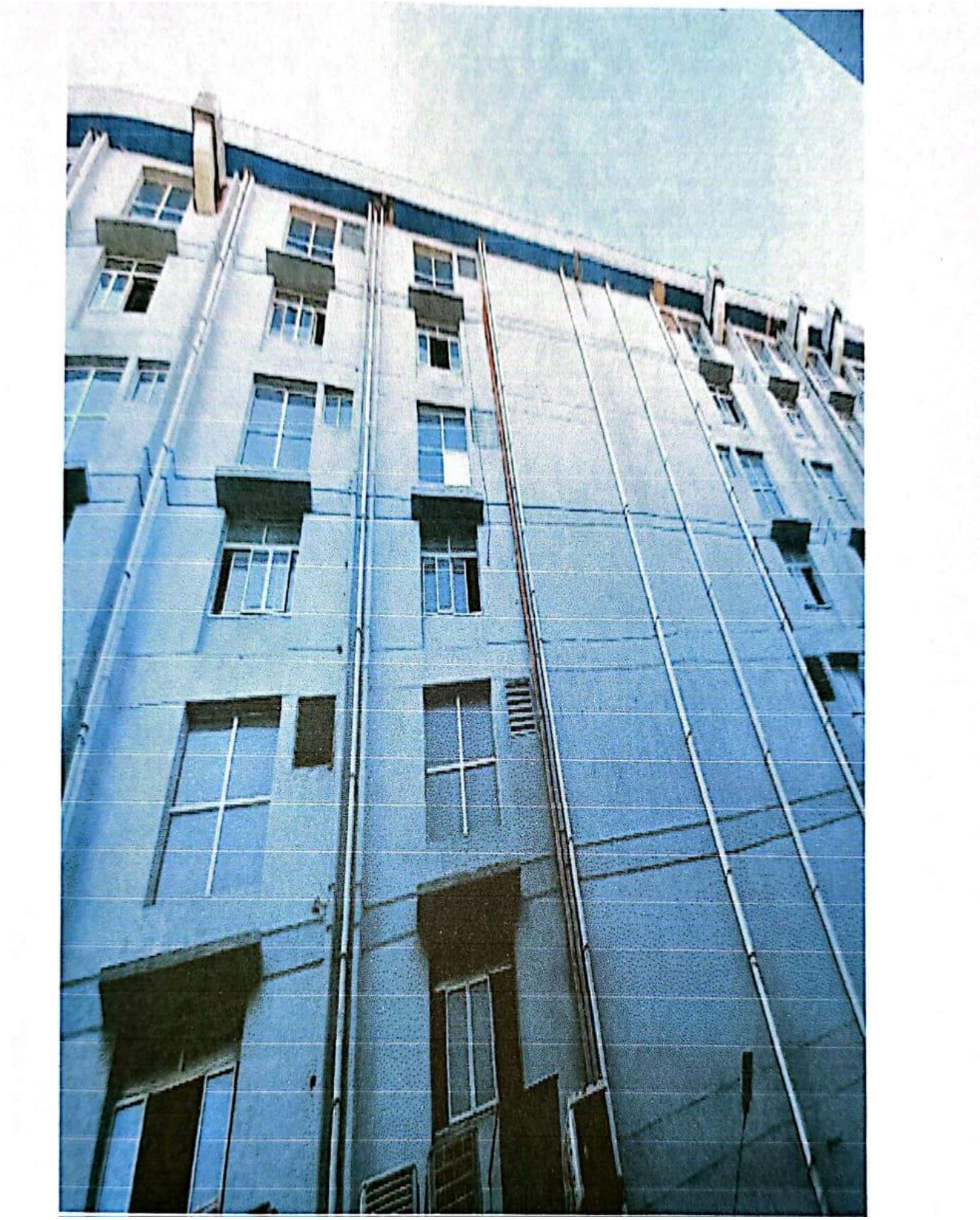


Figure 3.10: Site View Pipe of Study Building.

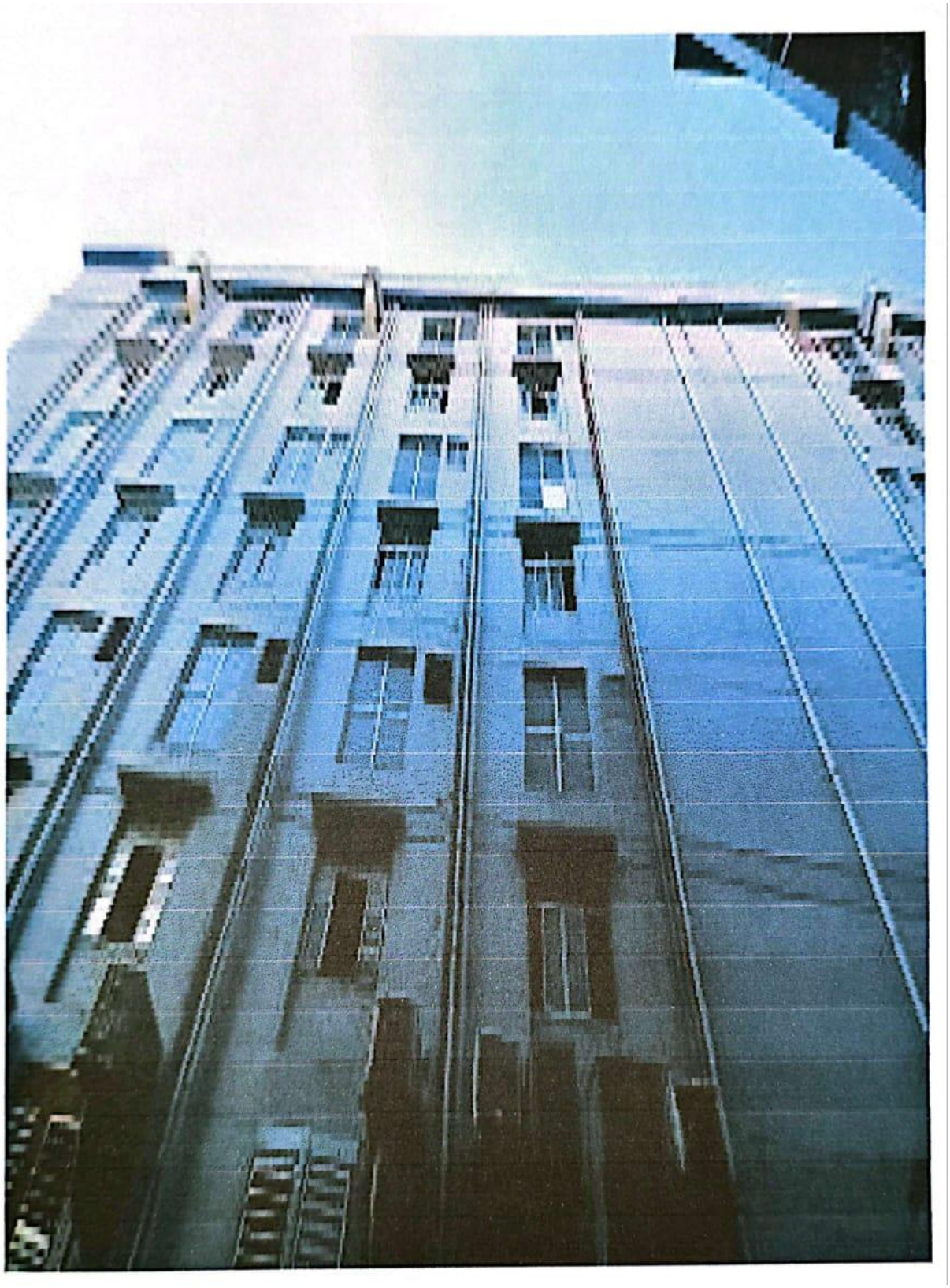


Figure 3.11: Site View of Study Building.

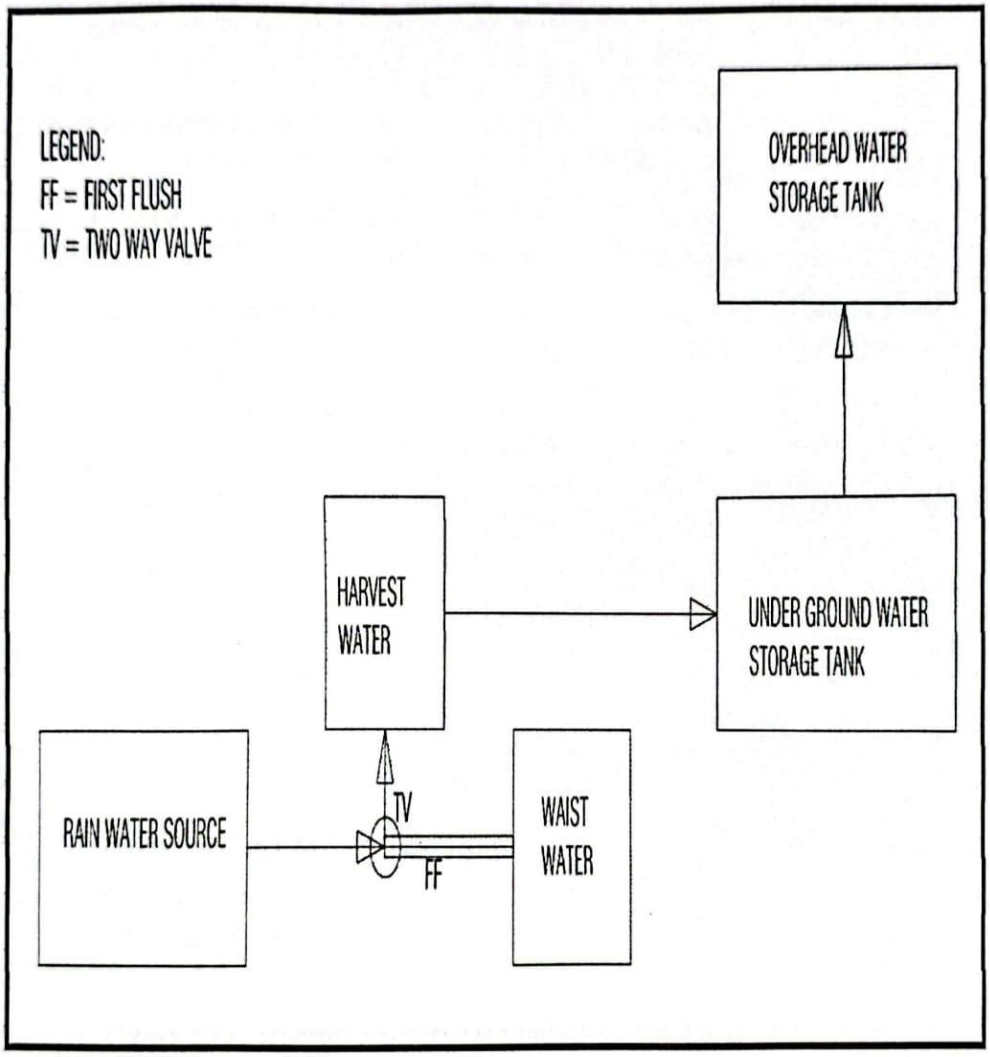


Figure 3.12: Process Diagram of Rainwater Harvesting Study Project.

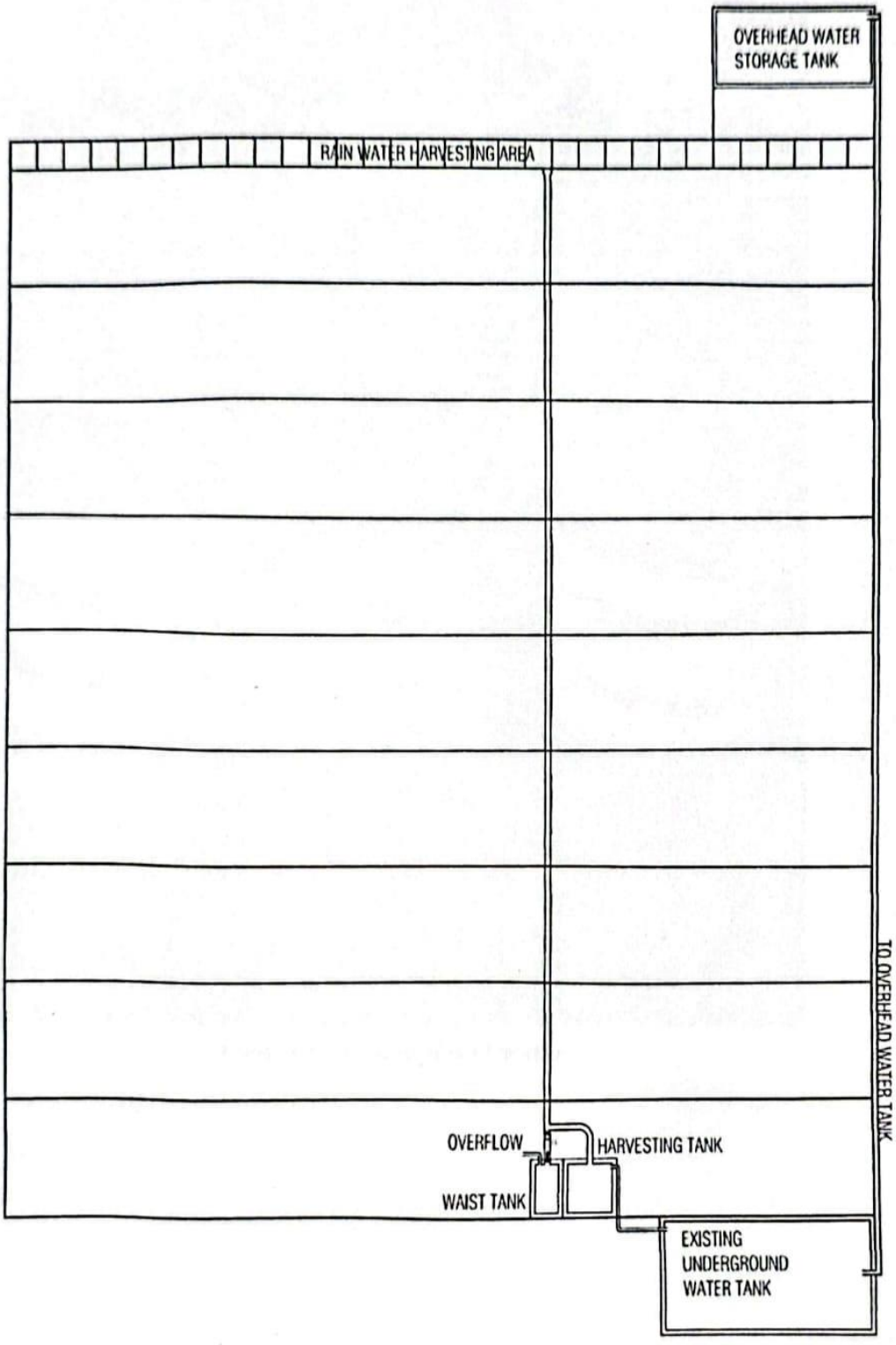


Figure 3.13: Sectional Elevation of Rainwater Harvesting Study Project.

Rainwater harvesting Study Project No-3

Roof top surface & proposed Rainwater Harvesting system.
Building Name: RFL #02 (Bizli Cable)
Location: Faridpur, Dhaka.
Roof Area: 84 m²

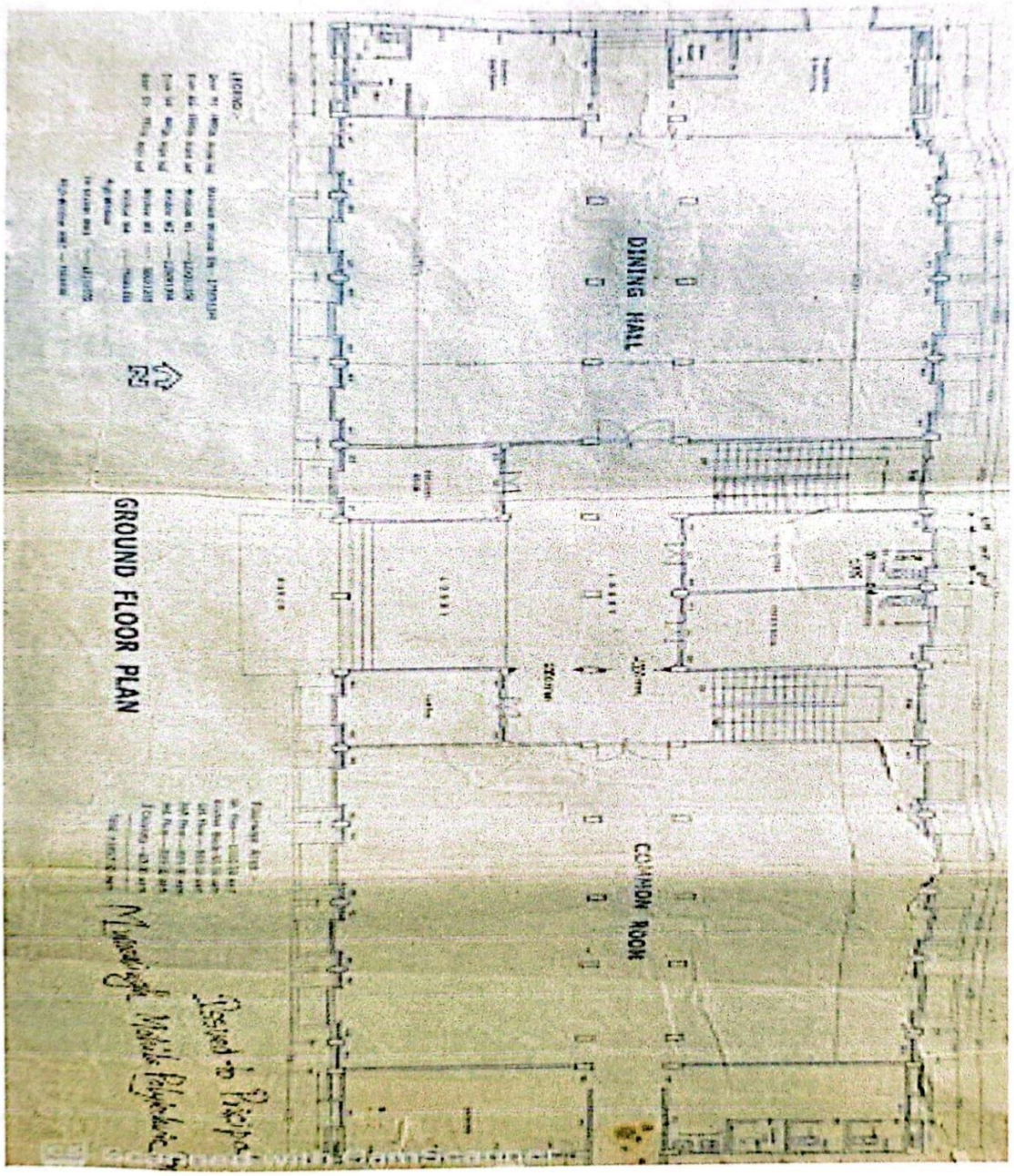


Figure 3.14: Roof Plan of study Building.



Figure 3.15: Roof top view of study Building.

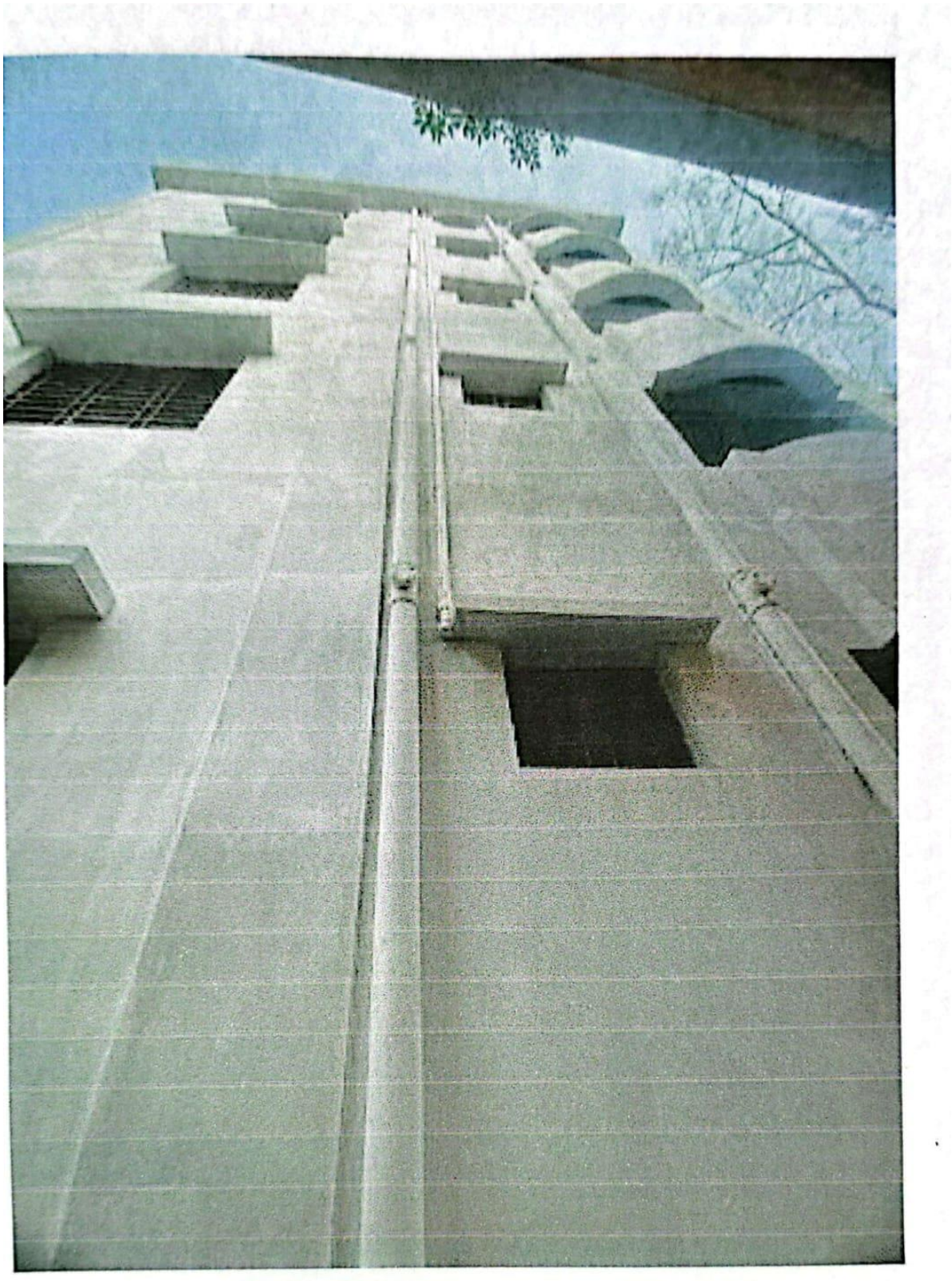


Figure 3.16: Site View of study Building.

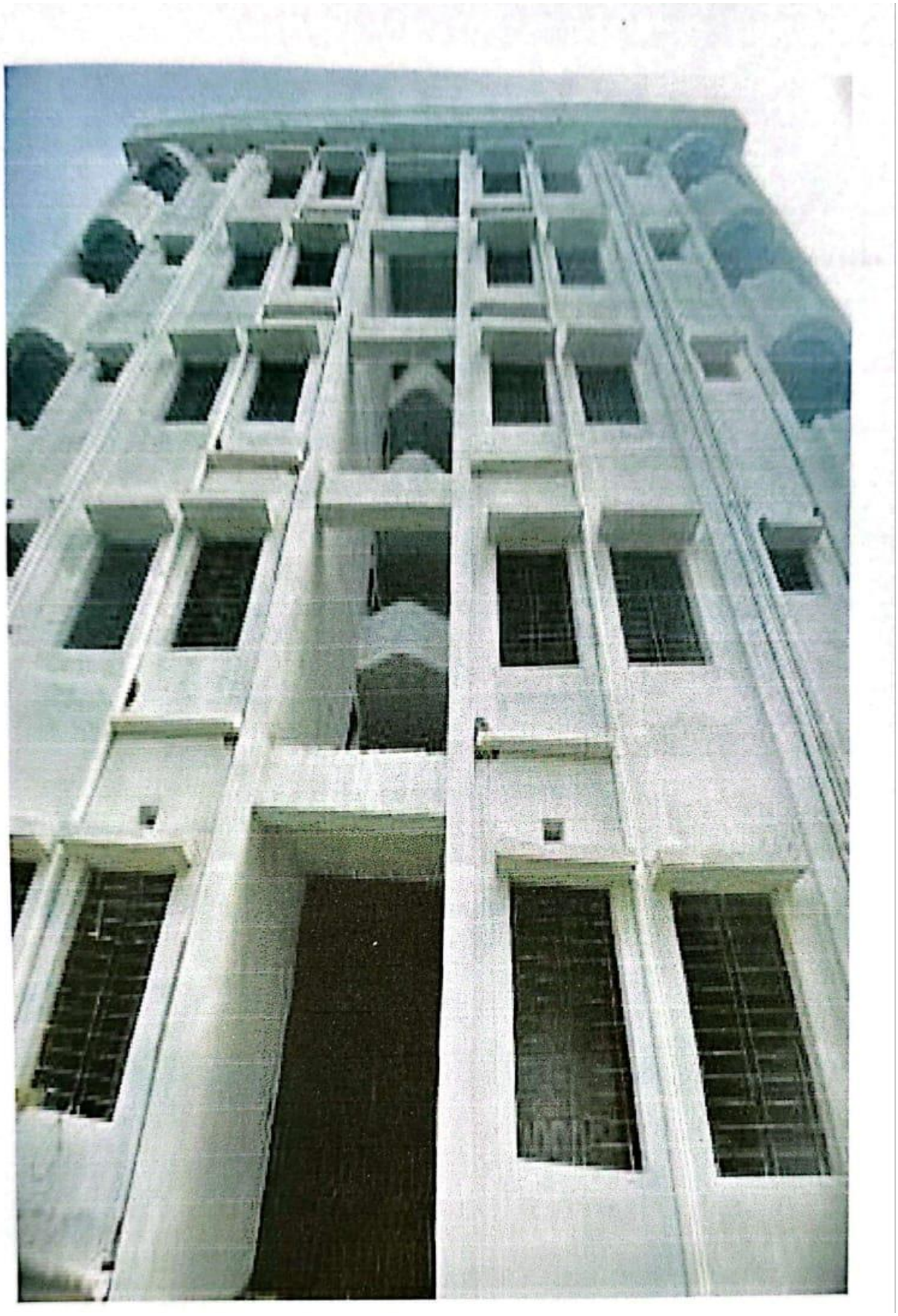


Figure 3.17: Site View of study Building.

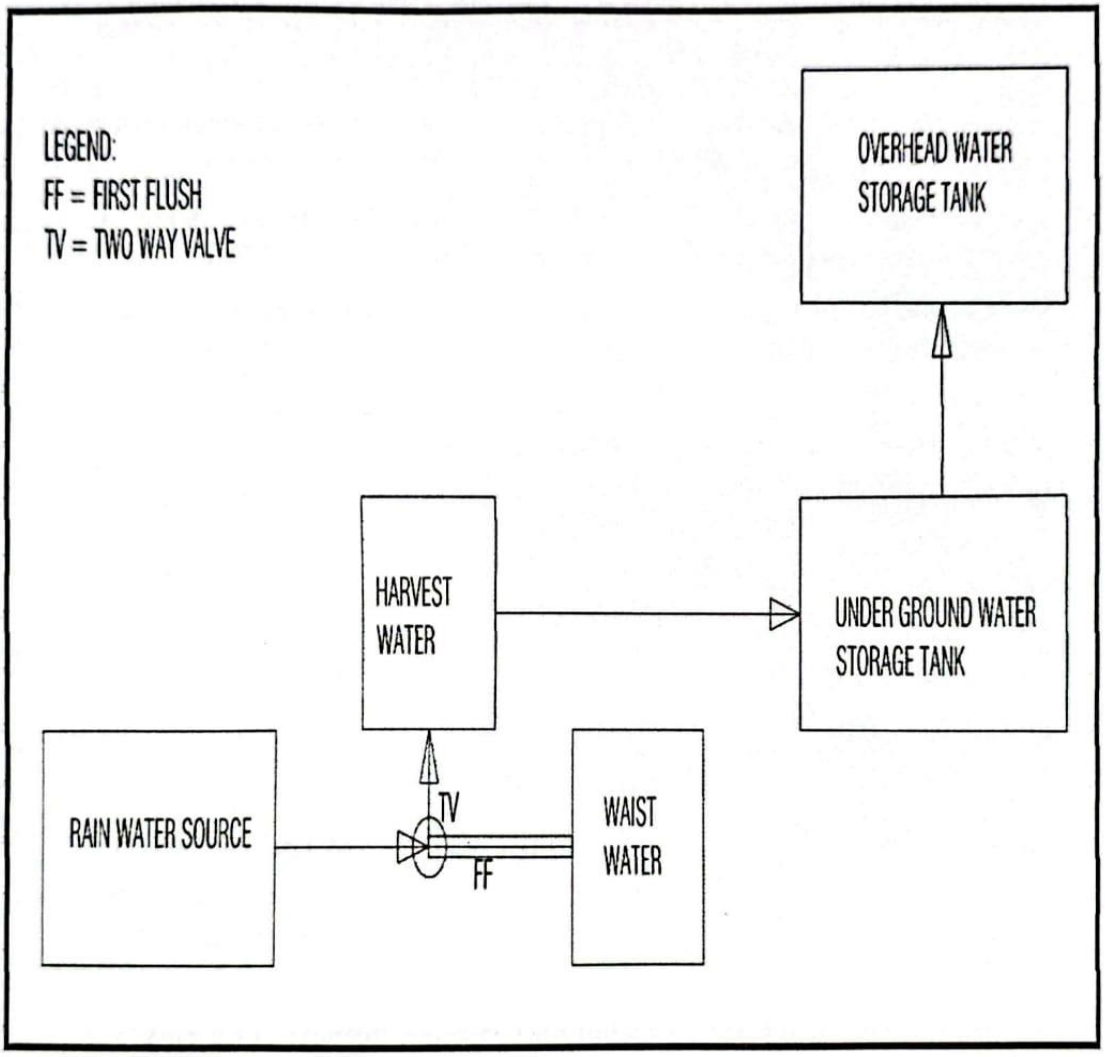


Figure 3.18: Process Diagram of Rainwater Harvesting Study Project.

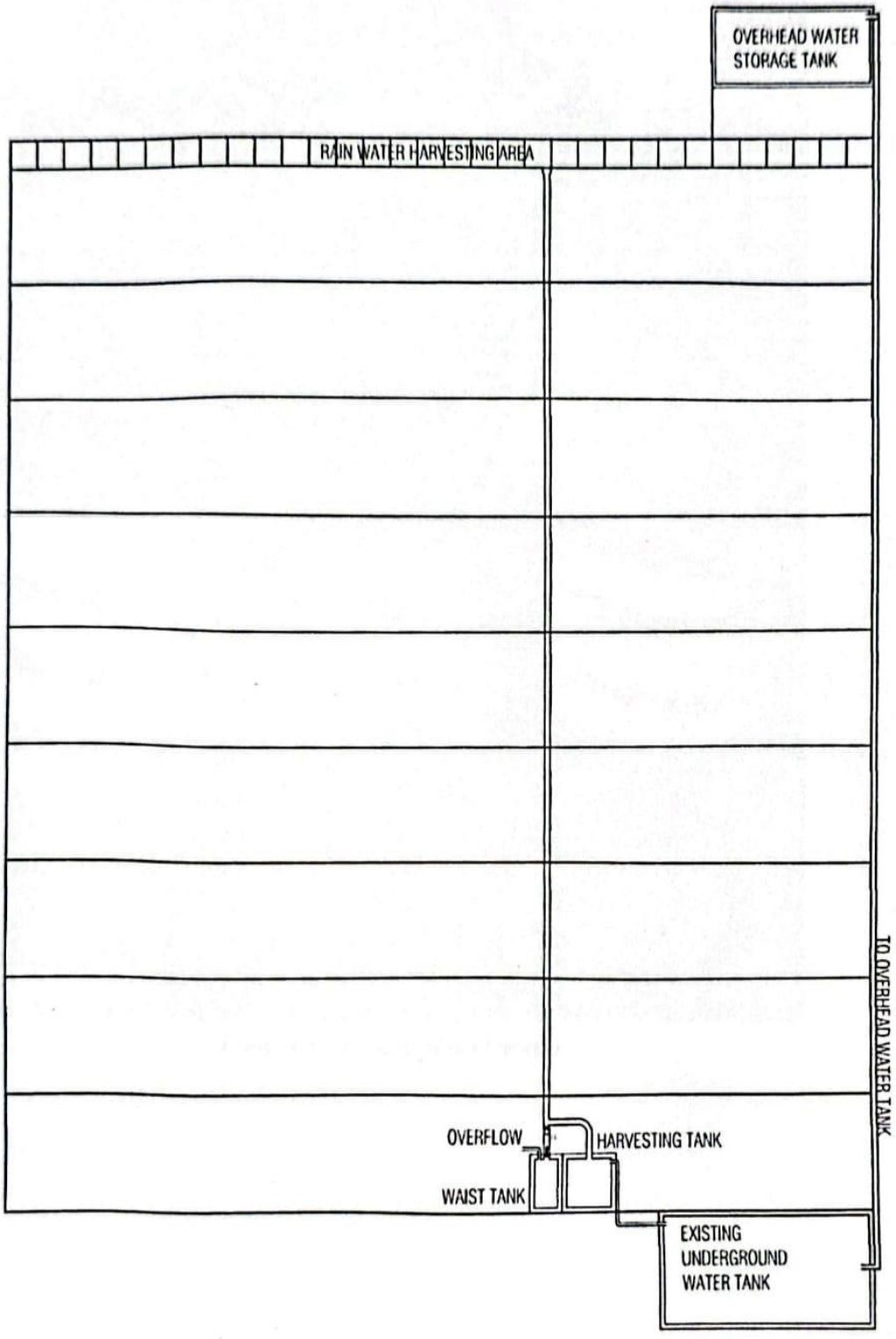


Figure 3.19: Sectional Elevation of Rainwater Harvesting Study Project.

Rainwater harvesting Study Project No-4

Roof top surface & proposed Rainwater Harvesting system.
Building Name: RFL #02 (Bizli Cable)
Location: Uttara, Dhaka.
Roof Area: 297.44 m^2



Figure 3.20: Site Elevation of Rainwater Harvesting Study Project.



Figure 3.21: Roof top View of Rainwater Harvesting Study Project.



Figure 3.22: Main elements of a guttering system

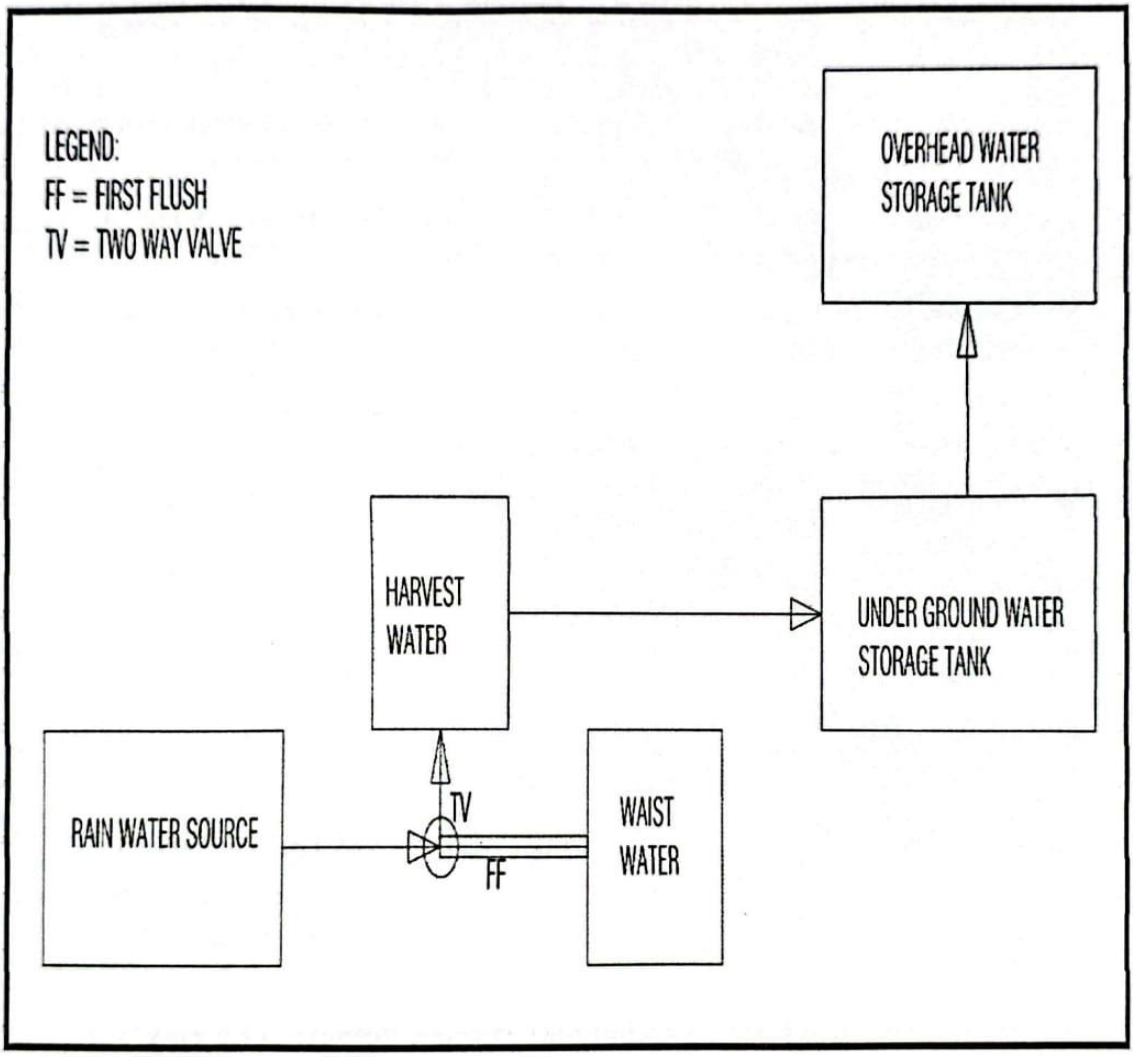


Figure 3.23: Process Diagram of Rainwater Harvesting Study Project.

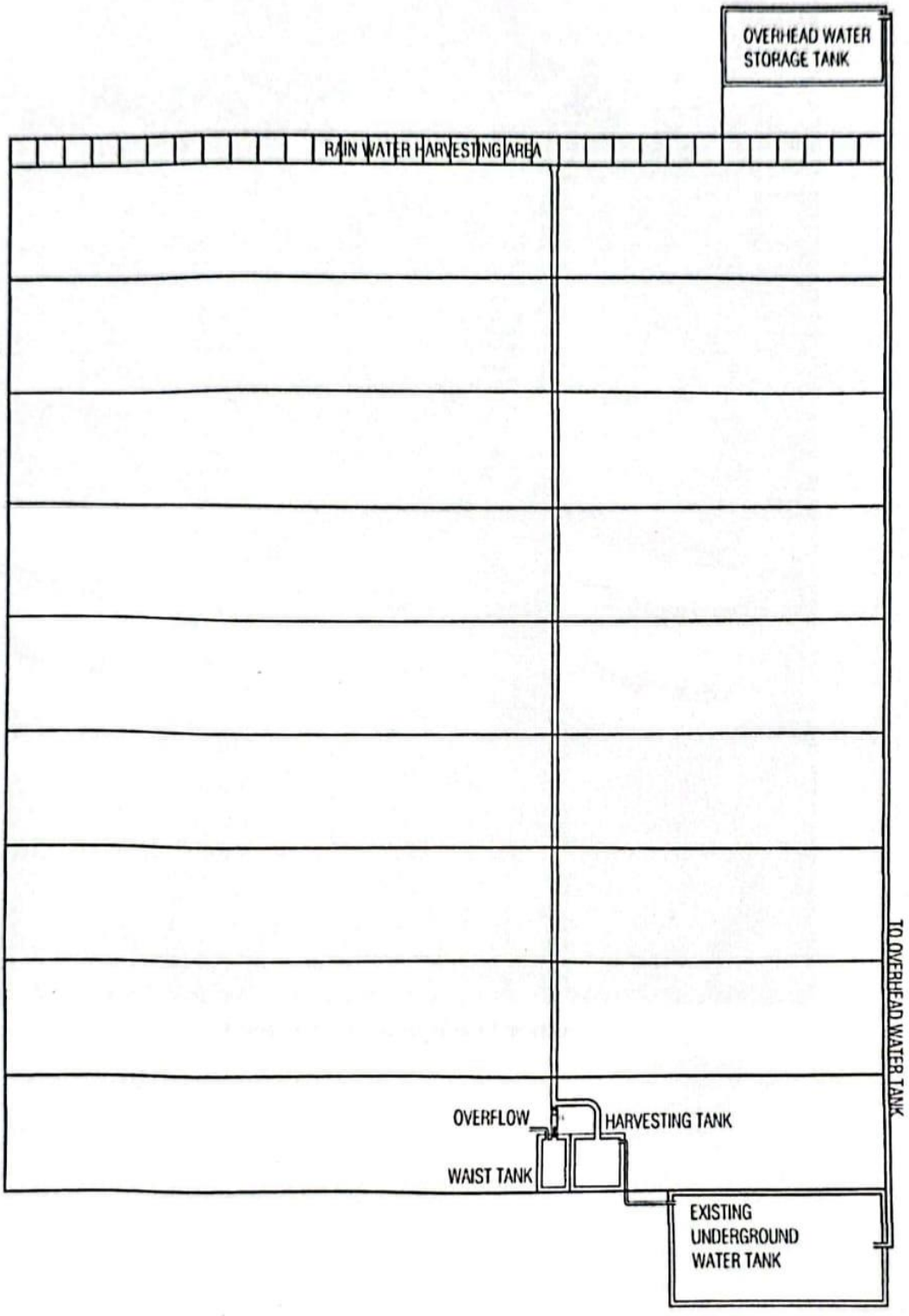


Figure 3.24: Sectional Elevation of Rainwater Harvesting Study Project.

1.3 Summary

1. Rainfall data for the last 10 years and monthly.
2. Basic Water Requirements for Human Activities.
3. Catchment area data.
4. Daily water demand and supply by Dhaka WASA.
5. Determination of rainwater quality for drinking water purpose according to BSTI & WHO Standards.

CHAPTER 4
Results and Discussion

1.4 Introduction

Rainfall data to find out the total available rainwater, rainfall amount is necessary. The rainfall data of the Dhaka city for the year 2010-2018 was collected from BMD. In our study area, there is no particular rain gauge station. So rainfall data from a representative location (recommended by BMD) was collected to estimate the rainwater volume. The collected rainfall data for the year 2010-2018 is given in Table 4.2
For the last ten years (2012-2022) Station name: Dhaka.
Monthly and annual total rainfall in millimeter

Table: 4.2: Annual Rainfall in the Dhaka City.

Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Annual
2010	0	48	22	37	177	308	167	340	169	174	0	81	1523
2011	0	0	20	123	235	314	356	409	207	112	0	0	1776
2012	10	1	37	269	137	175	226	282	81	38	68	5	1329
2013	0	8	26	32	378	325	302	212	172	131	0	4	1590
2014	0	12	10	80	147	342	212	391	156	49	0	0	1399
2015	3	17	4	166	185	375	623	395	346	51	0	1	2166
2016	1	15	46	213	679	136	216	162	210	76	44	0	1798
2017	8	29	66	156	339	340	373	317	300	172	34	13	2147
2018	0	3	34	324	690	358	356	473	145	33	12	52	2480

Table: 4.3: Yearly rainfall hydrograph (2010-2018)

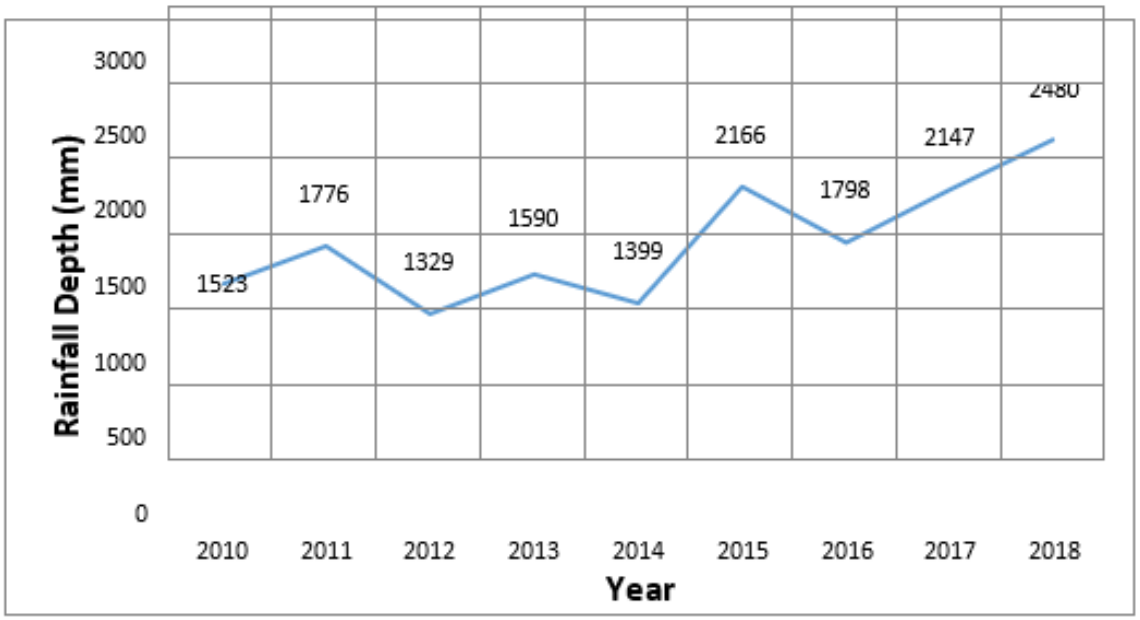


Table: 4.4: Monthly rainfall hydrograph (2010-2018)

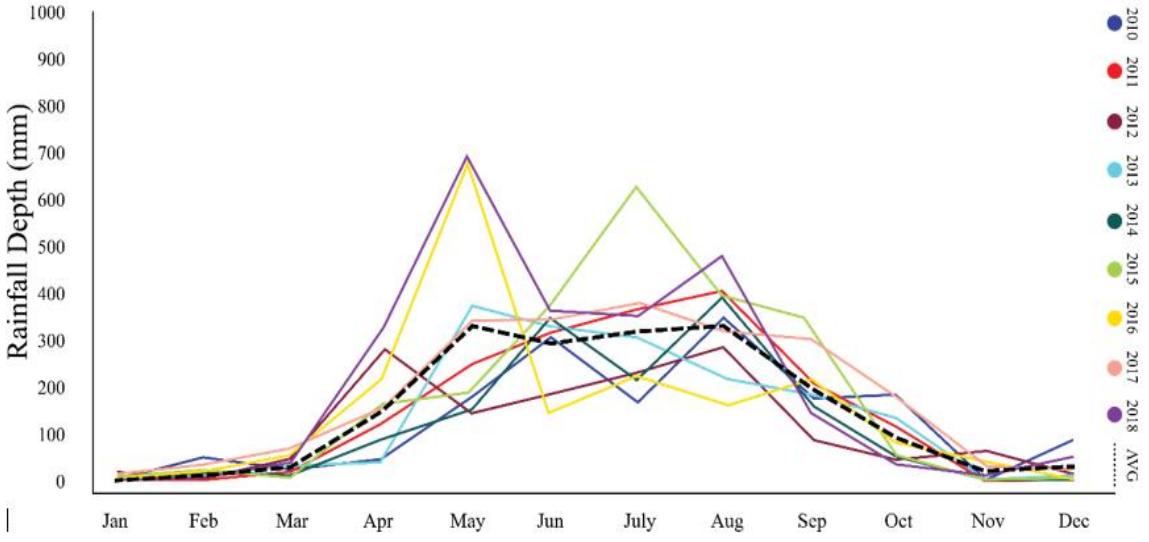


Table 4.2 illustrate the monthly and annual rainfall in the Dhaka city. The figure 4.2 shows the annual rainfall from 2010 to 2018. Where the maximum annual rainfall occurred in 2018 which was 2480mm. The average annual rainfall is 1800mm. The annual minimum rainfall in the 9 years is 1329mm on the 2012. However from the figure 4.3 & 4.4 which shows year wise monthly rainfall. The graph indicates that maximum rainfalls in the month of April-May. This graph also shows that the rainfall starts from March and continue to October. In the Dhaka city's inhabitants can get rainwater for more or less 8 months.

Table: 4.5 Water Consumption Rate

Sl. No	Use	Consumption(l/p/d)
1	Drinking	5
2	Cooking	5
3	Washing clothes	20
4	Bathing (including ablution)	55
5	Washing utensils	10
6	Cleaning house	10
7	Toilet flushing	30
	Total	135

Domestic Water requirement in Dhaka city

Daily water consumption depends on different variables such as

(1) Total number of residents in an apartment.

(2) Daily per capita use of plumbing fixtures such as lavatories, showers, water closets, etc.

One of the fastest growing cities of the world, Dhaka has a high daily water consumption rate. Water is used for various purposes. From drinking purpose to toilet flushing, water is required. There are several studies focusing on daily demand of Dhaka city. According to a research paper of "Unnayan Onneshan" titled: "DWASA has projected water demand as 150 liters per person per day (l/p/d). Empirical evidence shows that one-third of the city dwellers receive only 40 l/p/d and they have to manage their daily activities with this little amount of water. Only 5.1 percent of total population of Dhaka city receives more than 60 l/p/d. On an average, 42.8 percent of the respondents can receive basic requirement of 50 l/p/d and the rest (57.8 percent) are suffering from water scarcity despite piped connection. According to another research of "Center for Science & Environment,"

the daily water consumption rate has estimated 135 l/p/d. it is shown below in Figure 4.3: In this study, including five buildings were take into consideration of different storied and units. The main catchment is the roof top of the building. Building catchment area were calculated. The catchment areas are 134.96 m^2, 143.23 m^2, 84 m^2, 297. 44 m^2, for 1^{st}, 2^{nd}, 3^{rd} & 4^{th} catchment respectively.

Rainwater is a mixed with electrolyte that contains varying amounts of-

- Major and Minor ions
- Sodium
- Potassium
- Magnesium
- Calcium
- Chloride
- Bicarbonate
- Sulfate ions are major constituents together with ammonia
- Nitrogen and Other nitrogenous compounds

1.5 Summary

Each building roof top area has been calculated and accordingly surface runoff has been calculated using the equation as follows. Then catchment areas are multiplied by the average annual rainfall and runoff co-efficient, potential of rainwater harvesting would be

Potential of rainwater harvesting in each building= A×R×C

Where,

A= Area of rooftop in sq m R= Average annual rainfall

C= Coefficient of runoff (Which value is 0.90) Source: Center of science and

Environment, 2010 Water demand, D= nxqxd

Where,

n= No. of occupants

q= per capita water demand daily in m/day; and d= No. of days

Evaporation loss is negligible.

For 1st building:

C= 0.9

R= 1800mm A= 134.96 sq.m

Potential of rainwater harvesting for 1^{st} building= A×R×C
= 134.96×1800×0.9=218635.2

m^2×mm/year
= 218.64 cubic meter per year

1. *For drinking purpose*
Drinking water for one person= 5 l/p/d
So, Drinking water per person per year = 5×365 = 1825 l/p/year
Drinking water for 40 persons = 1825×40 = 73000 litter per year =73m3/yr

2. *For Cooking purpose*
Cooking purpose for one person= 5 l/p/d
So, Cooking purpose per person per year = 5×365 = 1825 l/p/year Cooking and Cooking purpose for 40 persons = 1825×40 = 73000 litter per year
=73m3/yr

3. *For Washing Clothes purpose*
Washing Clothes purpose for one person= 20 l/p/d
So, Washing Clothes purpose per person per year = 20×365=7300 l/p/year Washing Clothes purpose for 40 persons = 7300×40 =292000 litter per year
= 292 m^3 /yr

4. *For bathing (including ablution) purpose*
Bathing purpose for one person= 55l/p/d
So, bathing purpose per person per year = 55×365=20075 l/p/year Bathing purpose for 40 persons = 20075×40 =803000 litter per year
= 803 m^3 /yr

5. *For Washing Utensils purpose*
Washing Utensils purpose for one person= 10 l/p/d
So, Washing Utensils purpose per person per year = 10×365=3650 l/p/year Washing Utensils purpose for 40 persons = 3650×40= 146000 litter per year
= 146m^3 /yr

So, Cleaning House purpose per person per year = 10×365=3650 l/p/year Cleaning House purpose for 40 persons = 3650×40= 146000 litter per year
= 146m^3 /yr

6. *For Toilet Flushing purpose*
Toilet Flushing purpose for one person= 30 l/p/d
So, Toilet Flushing purpose per person per year = 30×365=10950 l/p/year Toilet Flushing purpose for 40 persons = 40950×40=438000 litter per year
= 438m^3 /yr

Total Water demand = (73+73 +292+803+146+146+438) =1971 m^3/yr

For 2nd building:

C= 0.9

R= 1800mm A= 143.23 sq.m

Potential of rainwater harvesting for 2nd building= A×R×C

= 143.23×1800×0.9

= 232032.6

m^2×mm/year =232.03 cubic meter per year

Water demand: For 70 persons

1. *For drinking purpose*

Drinking water for one person= 5 l/p/d

So, Drinking water per person per year = 5×365 = 1825 l/p/year Drinking water for 70 persons = 1825×70 = 127750 litter per year

= 127.75 m^3 /yr

2. *For Cooking purpose*

Cooking purpose for one person= 5 l/p/d

So, Cooking purpose per person per year = 5×365 = 1825 l/p/year Cooking purpose for 70 persons = 1825×70 = 127750 litter per year

= 127.75 m^3 /yr

3. *For Washing Clothes purpose*

Washing Clothes purpose for one person= 20 l/p/d

So, Washing Clothes purpose per person per year = 20×365=7300 l/p/year

Washing Clothes purpose for 70 persons = 7300×70 =511000 litter per year

= 511 m^3 /yr

4. *For bathing (including ablution) purpose*

Bathing purpose for one person= 55l/p/d

So, bathing purpose per person per year = 5 5×365=20075 l/p/year Bathing purpose for 70 persons = 20075×70 =1405250 litter per year

= 1405.25 m^3 /yr

5. *For Washing Utensils purpose*

Washing Utensils purpose for one person= 10 l/p/d

So, Washing Utensils purpose per person per year = 10×365=3650 l/p/year Washing Utensils purpose for 70 persons = 3650×70=255500 litter per year

= 255.50m^3 /yr

6. *For Cleaning House purpose*
Cleaning House purpose for one person= 10 l/p/d
So, Cleaning House purpose per person per year = 10×365=3650 l/p/year Cleaning House purpose for 70 persons = 3650×70= 255500 litter per year
= 255.50m^3 /yr

7. For Toilet Flushing purpose
Toilet Flushing purpose for one person= 30 l/p/d
So, Toilet Flushing purpose per person per year = 30×365=10950 l/p/year Toilet Flushing purpose for 70 persons = 10950×70=766500 litter per year
= 766.50m^3 /yr

Total Water demand= (127.75+127.75+511+1405.25+255.50+255.50+766.50)
=3449.25m^3/yr

For 3rd building:
C= 0.9
R= 1800mm
A= 84 sq.m
Potential of rainwater harvesting for 3rd building= A×R×C
= 84×1800×0.9
= 136080m^2×mm/year
= 136.08 cubic meter per year
Figure Water demand:
For 18 persons

1. *For drinking purpose*
Drinking water for one person= 5 l/p/d (Table 3.2) So,Drinking water per person per year=5×365=1825 l/p/year
Drinking water for 18 persons = 1825×18 = 32850 litter per year
= 32.85m^3 /yr
2. *For Cooking purpose*

Cooking purpose for one person= 5 l/p/d
So, Cooking purpose per person per year = 5×365 = 1825 l/p/year Cooking purpose for 18 persons = 1825×18 = 32850 litter per year
= 32.85 m^3 /yr

3. *For Washing Clothes purpose*

Washing Clothes purpose for one person= 20 l/p/d

So, Washing Clothes purpose per person per year = 20×365=7300 l/p/year Washing Clothes purpose for 18 persons = 7300×18 =131400 litter per year

= 131.40 m^3 /yr

4. *For bathing (including ablution) purpose*

Bathing purpose for one person= 55l/p/d

So, bathing purpose per person per year = 5 5×365=20075 l/p/year Bathing purpose for 18 persons = 20075×18 =361350 litter per year

= 361.35m^3 /yr

5. *For Washing Utensils purpose*

Washing Utensils purpose for one person= 10 l/p/d

So, Washing Utensils purpose per person per year = 10×365=3650 l/p/year Washing Utensils purpose for 18 persons = 3650×18=65700 litter per year

= 65.70m^3 /yr

6. *For Cleaning House purpose*

Cleaning House purpose for one person= 10 l/p/d

So, Cleaning House purpose per person per year = 10×365=3650 l/p/year Cleaning House purpose for 18 persons = 3650×18= 65700 litter per year

= 65.70m^3 /yr

7. *For Toilet Flushing purpose*

Toilet Flushing purpose for one person= 30 l/p/d

So, Toilet Flushing purpose per person per year = 30×365=10950 l/p/year Toilet Flushing purpose for 18 persons = 10950×18=197100 litter per year

= 197.10m^3 /yr

Total Water demand = (32.85+32.85 +131.40+361.35+65.70+65.70+197.10)

=886.95 m^3/yr

For 4th building:

C= 0.9

R= 1800mm A= 297.44 sq.m

Potential of rainwater harvesting for 4th building= A×R×C

= 297.44×1800×0.9

= 481852.8m^2×mm/year

= 481.85 cubic meter per year

Water demand:

1. *For drinking purpose*

Drinking water for one person= 5 l/p/d (Table 3.2) So, Drinking water per person per year = 5×365 = 1825 l/p/year

Drinking water for 95 persons = 1825×95 = 173375 litter per year

= 173.37m^3 /yr

2. *For Cooking purpose*

Cooking purpose for one person= 5 l/p/d

So, Cooking purpose per person per year = 5×365 = 1825 l/p/year

Cooking purpose for 95 persons = 1825×95 =173375litter per year

= 173.37m^3 /yr

3. *For Washing Clothes purpose*

Washing Clothes purpose for one person= 20 l/p/d

So, Washing Clothes purpose per person per year = 20×365=7300 l/p/year

Washing Clothes purpose for 95 persons = 7300×95 =693500 litter per year

= 693.50 m^3 /yr

4. *For bathing (including ablution) purpose*

Bathing purpose for one person= 55l/p/d

So, bathing purpose per person per year = 5 5×365=20075 l/p/year Bathing purpose for 95 persons = 20075×95 =1907125 litter per year

= 1907.13m^3 /yr

5. *For Washing Utensils purpose*

Washing Utensils purpose for one person= 10 l/p/d

So, Washing Utensils purpose per person per year = 10×365=3650 l/p/year Washing Utensils purpose for 95 persons = 3650×95=346750 litter per year

= 346.75m^3 /yr

6. *For Cleaning House purpose*

Cleaning House purpose for one person= 10 l/p/d

So, Cleaning House purpose per person per year = 10×365=3650 l/p/year Cleaning House purpose for 95 persons = 3650×95=346750litter per year

= 346.75m^3 /yr

7. *For Toilet Flushing purpose*

Toilet Flushing purpose for one person= 30 l/p/d

So, Toilet Flushing purpose per person per year = 30×365=10950 l/p/year Toilet Flushing purpose for 95 persons = 10950×95=1040250 litter per year

= 1040.25m^3 /yr

Total Water demand = (173.37+173.37+693.50+1907.13+346.75+346.75+1040.25)

= 4681.12 m^3/yr

CHAPTER 5
Conclusions and Future Works

1.6 Conclusions

The harvesting of rainwater simply involves the collection of water from surfaces on which rain falls, and subsequently storing this water for later use. One method of rainwater harvesting is rooftop harvesting.

Rainwater harvesting is environmentally harmless, it has no negative impacts on it's users. Moreover if certain purification can be obtained, it had become the major source of drinking water. City like Dhaka where a huge amount of city dwellers struggling amount everyday for getting potable drinking water, rainwater harvesting will become a blessing for them. Rainwater harvesting can also effects to achieve this goal. By using rainwater, existing generation can help to survive the future generation without any negativity.

In this research water purification was considered with laboratory test for water quality parameters such as chemical, mineral and microbial characteristics. Laboratory experiments on water quality had been done in three different categories. They are (1) Chemical characteristics of rainwater (2) Mineral characteristics of rainwater and (3) Microbiological characteristics of rainwater. In all the experiments showed that the results are safe with respect to Bangladesh and WHO standard respectively. The people of Bangladesh specially those who are living in countryside are not eager to use rainwater as drinking as well as household uses. Awareness may be developed through motivation in using rainwater and rainwater harvesting.

1.7 Limitations and Recommendations for Future Works

From the study, the following recommendations may be made:

(1) Rainwater may be used potable as well as domestic (household) purpose.
(2) Awareness through motivation may be developed to the people for using rainwater.
(3) A-3D model may be developed for the solution of RWH system to make it easily comprehensive to the users.
(4) The model proposed in recommendation-3 along with the computer programs, from the guideline for the design and installation of the rainwater harvesting system.
(5) Design of RWH system with cost analysis may be done as further study.
(6) DWASA Can involve themselves in developing rainwater harvesting system.

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